Smoke Forecasting for the 2015 Wildfire Season in Washington State

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2016 Northwest Weather Workshop

Overview

- The 2015 Fire Season
- Wildland Fire Air Quality Response Program
- Smoke forecasts and what we are learning
- Moving forward

2015 Wildfire Season

Over one million acres burned in Washington State.

North Star Fire – approximately 218,000 a.
Tunk Block Fire - approximately 165,000 a.
Okanogan Complex - approximately 133,000 a.
Chelan Complex - approximately 89,000 a.
Wolverine Fire – approximately 65,000 a.

Widespread smoke impact across Washington

- Public health and daily activities.
- Interfered with transportation and suppression operations.

https://www.google.com/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&ved=0ahUKEwiVyeO0i5zLAhUM4GMKHdMnBCAQjRwIBw&url=http%3A%2F%2Fq13fox.com%2F2015%2F08%2F20%2Flevel-3-evacuations-remain-in-chelan-fires%2F&psig=AFQjCNHCZCbeCzwuGjioJIYrwlsOIPhxHw&ust=1456804845955467

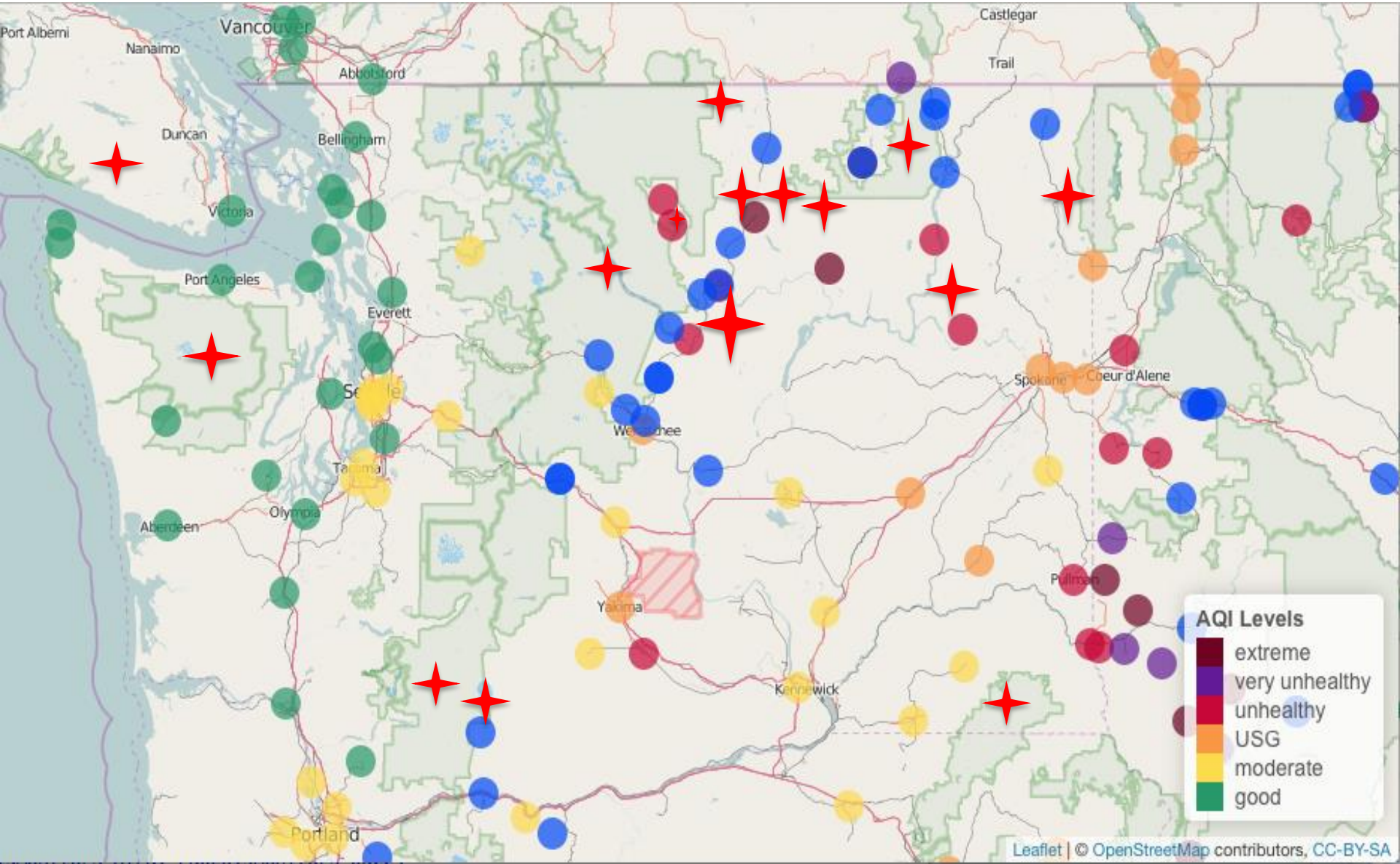
http://inciweb.nwcg.gov/photos/WAOWF/2015-07-03-1207-Wolverine-Creek-Fire/medium/2015_09_11-18.03.02.005-CDT.jpeg

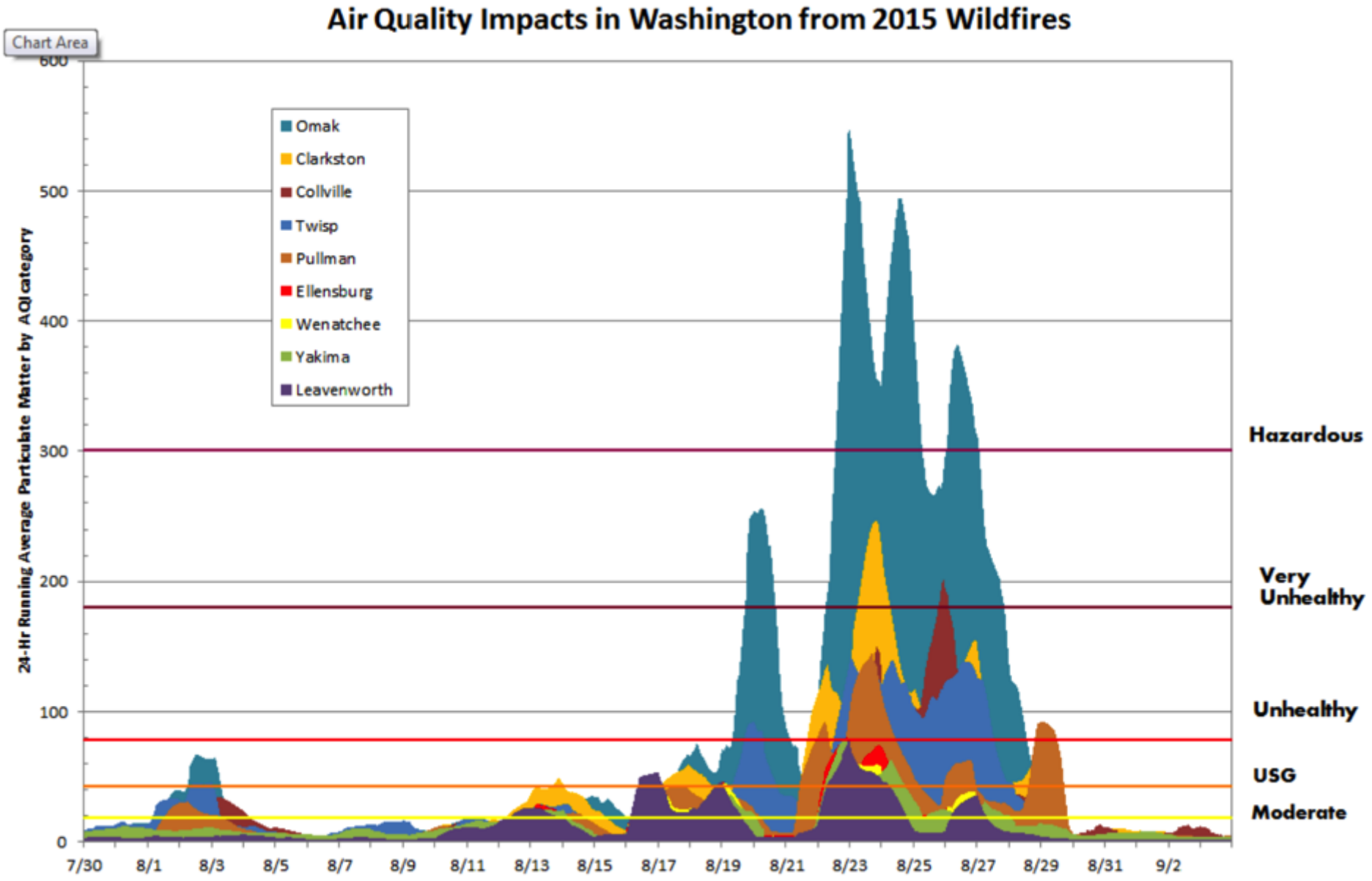
http://inciweb.nwcg.gov/photos/WAOWF/2015-07-03-1207-Wolverine-Creek-Fire/picts/2015_08_31-14.19.29.238-CDT.jpeg

2015 Wildfire Season

Fire Locations

Air Quality Monitors





From: Narrative Timeline of the Pacific Northwest 2015 Fire Season. USDA Forest Service.
http://www.wfmrda.nwcg.gov/docs/_Reference_Materials/2015_Timeline_PNW_Season_FINAL.pdf

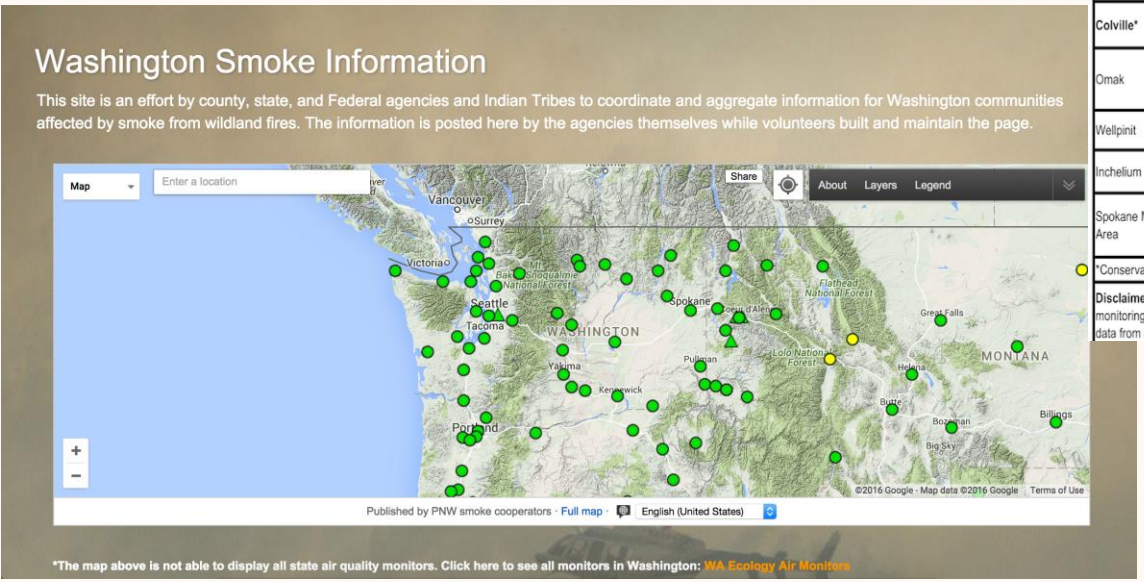
Wildland Fire Air Quality Response Program

Interagency response embedded in the fire management system:

- Enhanced monitoring
- Enhanced modeling
- Embedded specialist in Incident Command Team (Air Resource Advisor)
- Coordinated public outreach (w/ state and local agencies)

Air Resource Advisor (ARA)

Photo: Rick Graw, ARA Rough Fire



WASHINGTON SMOKE BLOG

http://wasmoke.blogspot.com/

Air Quality Report
NE Washington Area Command

Issue Date: 8/24/2015
Prepared by: Leland Tarnay

Fire Activity and smoke implications: There is a red flag warning out for all the fires in the region and emissions are likely to increase from current levels for the next couple days. Fire emissions under light winds and strong inversions will drive the variability in smoke impacts. Models are not capturing persistence of smoke under these inversions so forecast below assumes a pattern similar to previous periods with such strong inversions combined with high fire activity.

Weather synopsis and smoke implications: Upper level winds will be out of the SW, but inversions will be very strong. If inversions do break, relief from smoke trapped under them will in general be in the afternoon, between noon and 5 P.M. in places not directly in the path of plumes. Fires from farther afield (e.g., the Cougar Creek fire ~200 miles to the SW) may also contribute to smoke impacts if they become/remain active.

You can reduce your smoke exposure: The information below is intended to help people, where possible, to reduce and minimize their exposure to smoke by avoiding the worst times of day and timing their activities to the best times of day, while tailoring activity to the conditions most likely to manifest, as described below.

Monitoring: We are tentatively planning to deploy two new monitors to Chewelah and Pend Oreille.

Site	Today Monday (8/24) Air Quality	Tomorrow Tuesday (8/25) Air Quality	Day after Tomorrow Wednesday (8/26) Air Quality	Comments
Pend Oreille*	Unhealthy	Very Unhealthy	Very Unhealthy	Proximiity to activity on the Kaniksu Complex means that Very Unhealthy is may occur if fire continues to get nearer
Newport*	Unhealthy	Unhealthy	Unhealthy	Estimate based on analogous impacts at monitors with similar topography
Chewelah*	Unhealthy	Unhealthy	Unhealthy	Estimate based on analogous impacts at monitors with similar topography
Republic*	Very Unhealthy	Very Unhealthy	Very Unhealthy	Estimate based on analogous impacts at monitors with similar topography and proximity to fires
Colville*	Unhealthy	Unhealthy	Unhealthy	Estimate based on analogous impacts at monitors with similar topography
Omak	Hazardous	Hazardous	Hazardous	Fire activity is likely to continue to be high, with smoke coming from nearby, active fires in most directions and smoke remaining trapped beneath inversions.
Wellpinit	Unhealthy	Very Unhealthy	Very Unhealthy	Active parts of the nearby Carpenter Road fire may reach a point where the more directly impact Wellpinit at night.
Inchelium	Unhealthy	Unhealthy	Unhealthy	Data are spotty and variable so some relief moderate/USG may manifest in afternoons, if inversions break. Otherwise unhealthy.
Spokane Metro Area	Unhealthy	Unhealthy	Unhealthy	Mostly likely time for Unhealthy air is in evening, after 6 P.M.- best times of day (moderate to USG) have been early to late afternoon, before 6 P.M., but only if the inversion breaks.

*Conservatively Estimated Air Quality, no monitoring data available

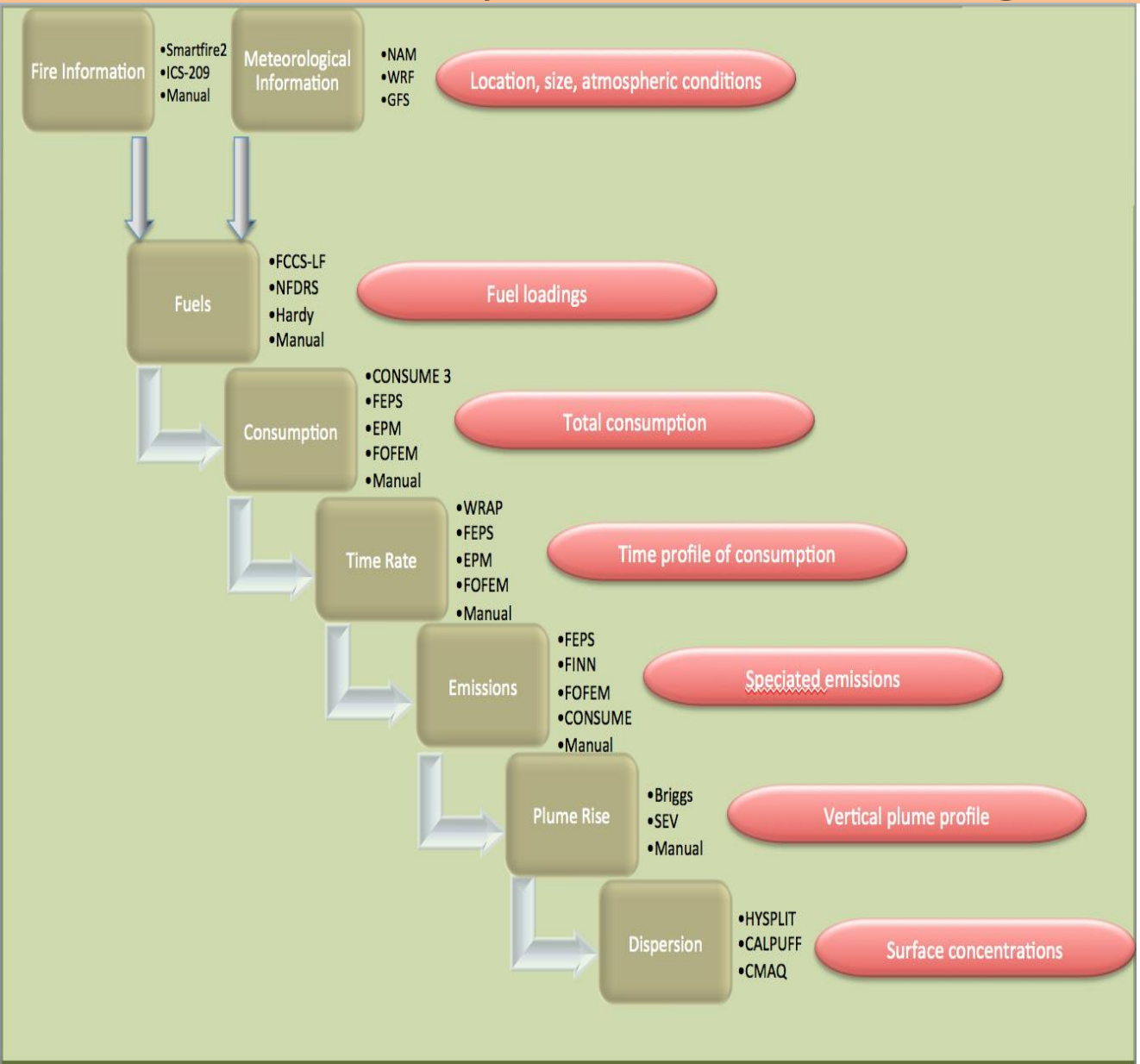
Disclaimer: Fire activity and weather may change quickly, and data from monitors can lag by an hour or two, so it's prudent to check outside visually to ensure that monitoring and patterns described above match actual conditions. These predictions are based on anticipated weather and fire activity. The air quality outlook is based on data from automated instruments that have not been subjected to a quality assurance review. AQI's estimated for sites with air monitors.

Trainings: 2013, 2014, 2015

Next Training: May 2016

Pete Lahm – Coordinator

Forecasting smoke impacts: BlueSky Smoke Modeling Framework



- **BlueSky** is a system used to simulate wildfire smoke
  - It is modular
  - Input meteorological forecast and fire information
  - predicts near-surface **1-hr** average **$PM_{2.5}$** concentrations
- BlueSky is run daily by the US Forest Service AirFire Team
- Output is available online for multiple domains across the US

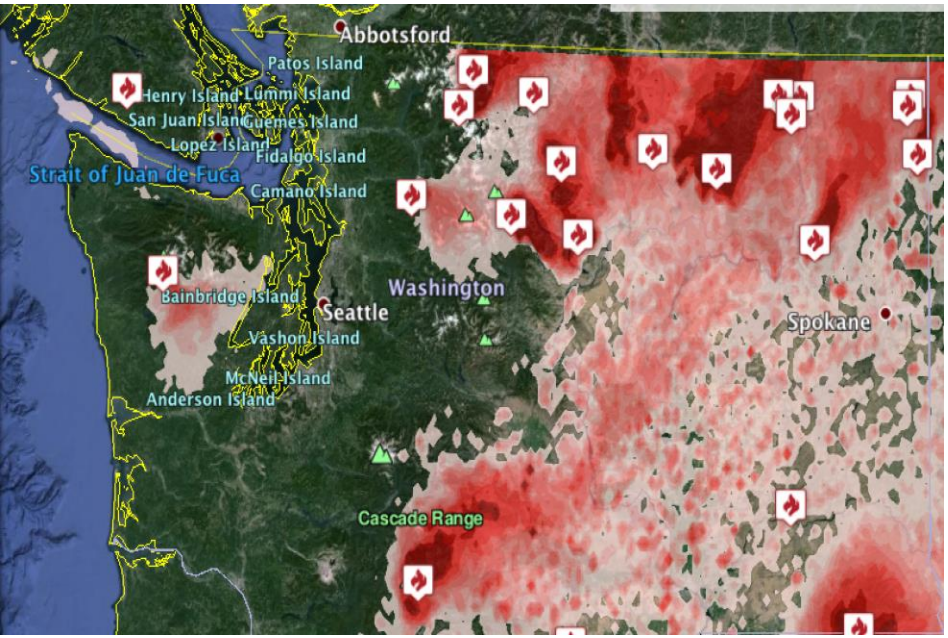
http://www.airfire.org/data/bluesky-daily/

- BlueSky is used by local and state air quality and health agencies to inform the public about potential smoke impacts

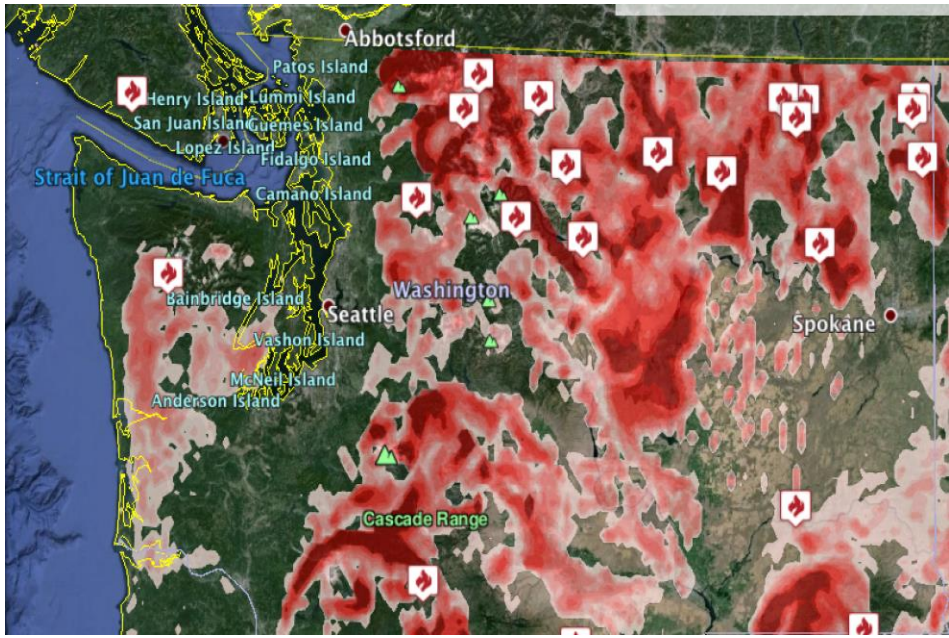
Things we are learning

- Forecast system is *useful* but has significant limitations
- Fire information available in real-time in 2015 was compromised by smoke and extended cloud cover
- Persistence forecast of fire information is limiting
- System as used in 2015 started with clean atmosphere (no-carry over smoke), making initial several hours ‘spin-up’
- Newer models and emissions factors appear to be beneficial
- Now able to compare different model resolutions including PNW 4 km and 1.33 km domains

4km Daytime



4km Nighttime



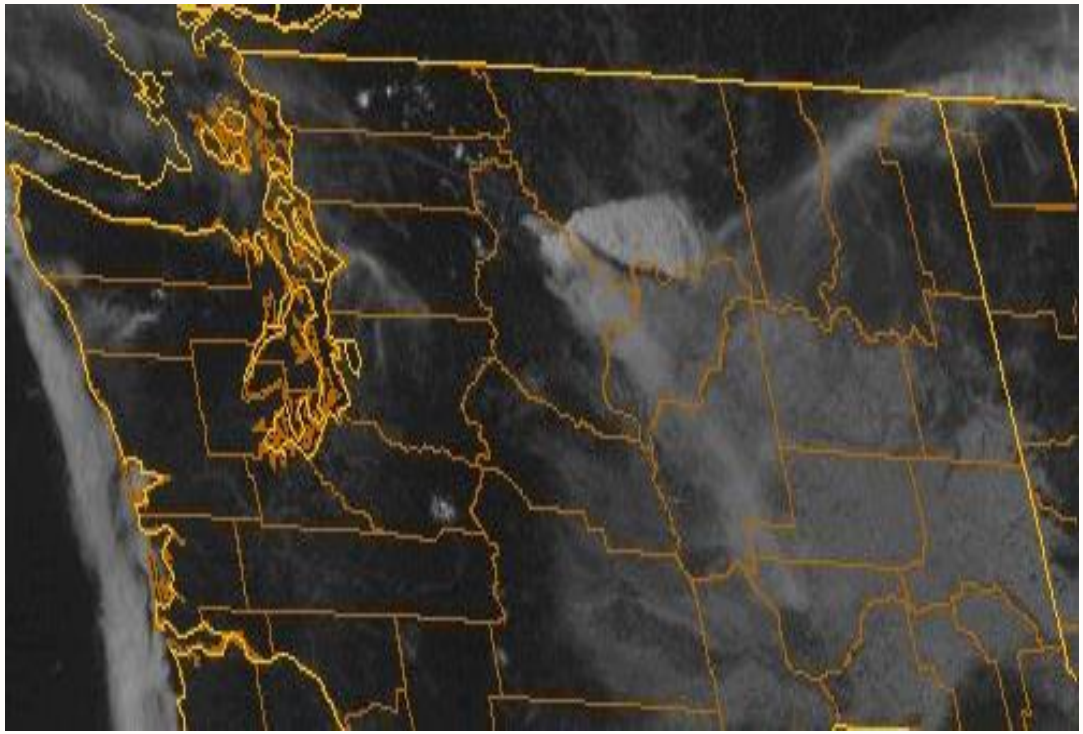
1.33km Daytime

1.33km Nighttime

4-km vs 1.33-km

- Different configurations showed differences in concentration and area affected by smoke.
- The higher resolution domain (1.33-km) terrain features are shown more detailed
  - Shows valley-mountain flows
  - Better when looking at a specific fire or smaller area of concern.
- The 4-km domain demonstrated greater utility when widespread smoke impacts from many fires occurred.
  - Runs faster, therefore forecast is available earlier
- The differences between the two resolutions are more significant at nighttime.
- Both domains are beneficial for BlueSky users.

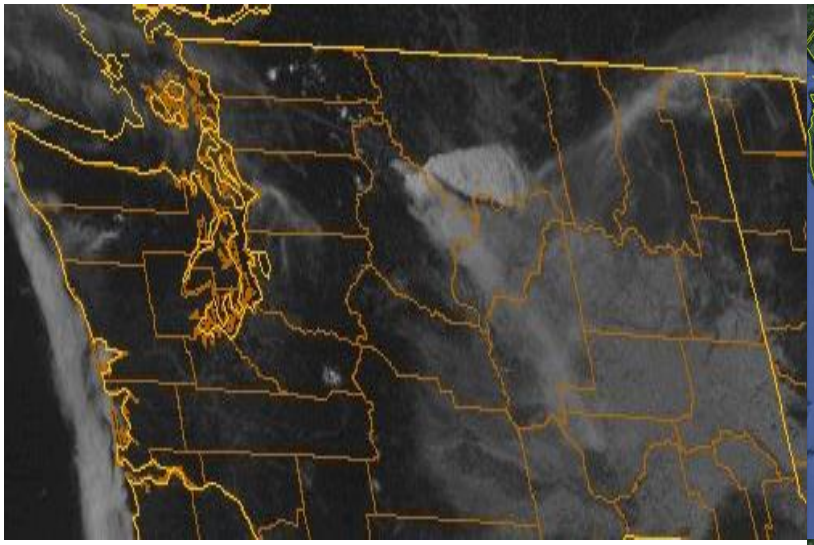
Plumes



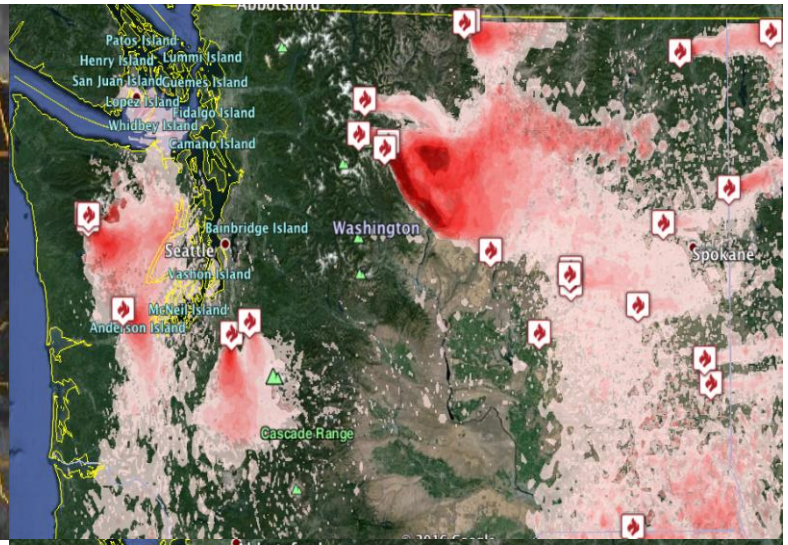
Satellite view for 08-01-2016 at 3:30pm local time,
showing the Wolverine Fire plume

Satellite view August 1st, 2015

Wolverine Fire Plume



4-km run



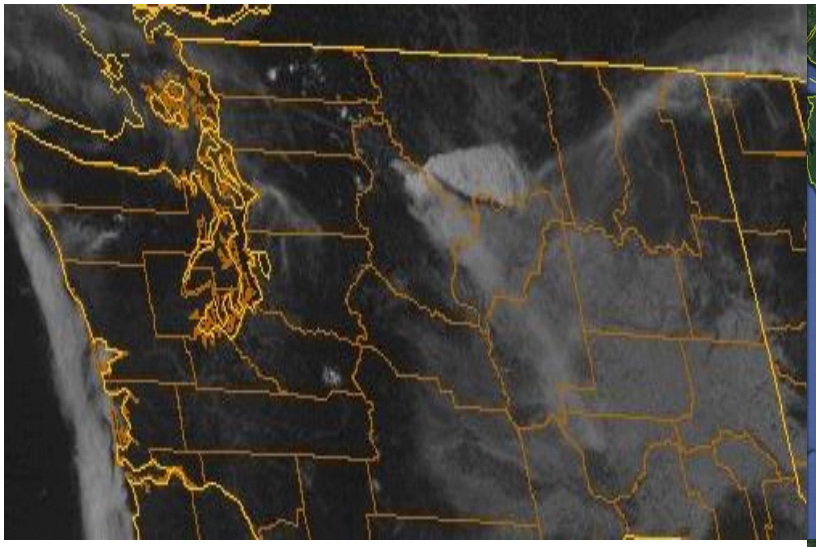
Surface

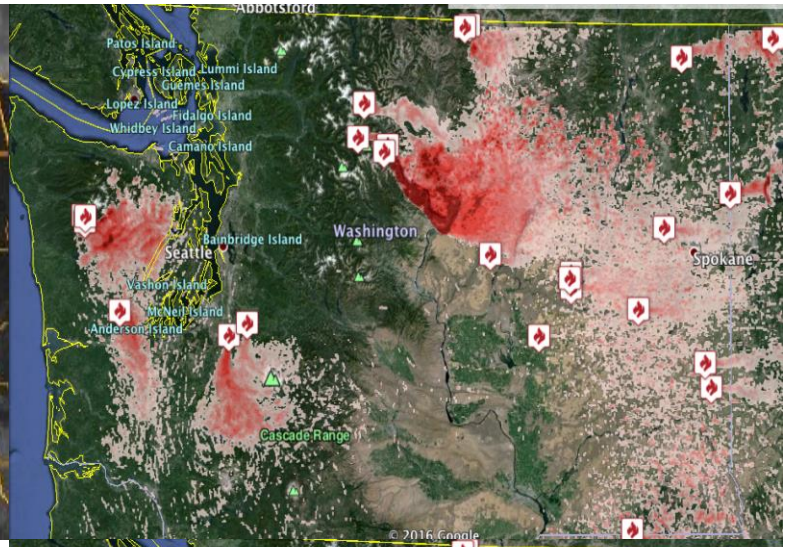
5000m

Satellite view August 1st, 2015

Wolverine Fire Plume

1.33 km run





Surface

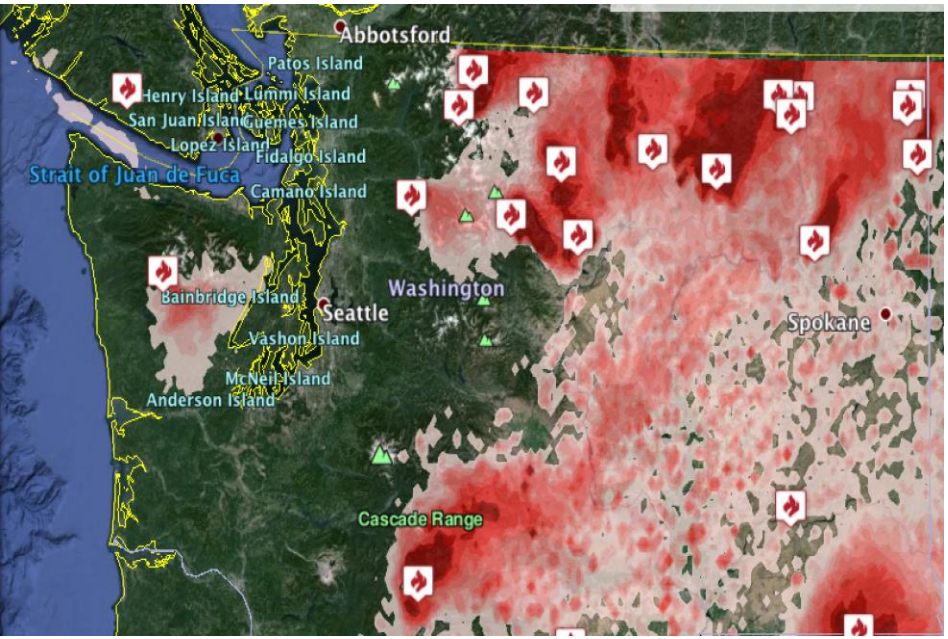
5000m

Plume Rise

- Fires often modeled as single plumes, lofting smoke unrealistically high and lowering ground impacts
- In reality, fires are made of many burning areas lofting smoke to various heights
- FRP based plume rise (SEV) may help.

Need a better fire forecast

4km Fire Growth = Persistence



4km Fire Growth = Observed

2016 Enhancements

For 2016, we are using the lessons learned from last year to improve the smoke forecasting system, including:

- Including carry over smoke from previous days.
- Faster updates to smoke model when there are new detects
- Simplified and improved fire information using fire detections and ground based fire reports.
- Including fire emissions from Canadian fires (through collaboration with Canadian consortium partners)
- New, simplified modeling infrastructure (BlueSky 4.0)
- Continued analysis of the optimal set of models to use within the framework (i.e. for fuels, time profile, and plume rise).
- Ensemble of model choices to be run for Pacific NW
- Statistical analyses of the forecast performance

Q & A

Chelan Complex Fire from the air Photo: Tim Joyce

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Modeling Chain Uncertainty

For regional air quality, biggest issues we see are:

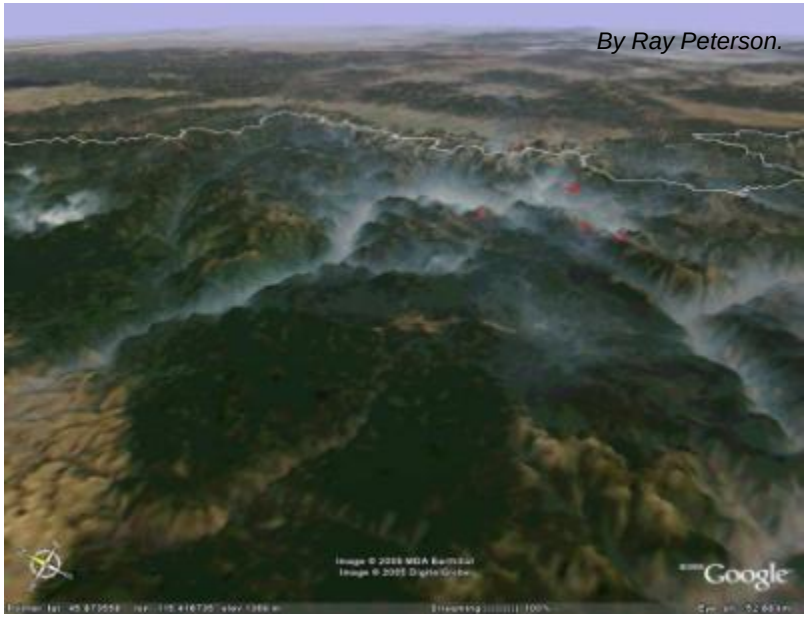
- Fire information
- Plume Rise
- Timing of emissions

Smoke Behavior
Valley Flows

Photo by Roger Ottmar.

- Smoke caught under a valley inversion

- Smoke can be transported by down-valley winds in the morning



By Ray Peterson.